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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 6 May 2003 with an application for Letters Patent number 525714 made by UNITEC INSTITUTE OF TECHNOLOGY.

Dated 8 July 2003.

Neville Harris
Commissioner of Patents

COMMISSIONER OF PATENTS TRADE MARKS & DESIGNS
NEW ZEALAND

525714

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PATENTS ACT, 1953

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06 MAY 2003

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PROVISIONAL SPECIFICATION

"A Panel and Related Wall Structure"

We, **UNITEC INSTITUTE OF TECHNOLOGY**, a New Zealand institution under the Education Act 1989 of Carrington Road, Mt Albert, Auckland, New Zealand and **MARK IRVINE TUCKER**, a New Zealand citizen of 17b Impala Place, Hillsborough, New Zealand, do hereby declare this invention to be described in the following statement:

The present invention relates to a panel and related wall structure and in particular to a sound absorbing panel and structure which although not essentially but, preferably is used as a building panel such as a wall or ceiling panel.

Wall and ceiling panels made out of a gypsum based material are well known. Such panels are often also called plaster board and consists of a core of gypsum material overlaid on each side by a paper sheet. Such panels are used to be placed against framing timber to provide a lining for an interior surface of a room of a house or building or the like. Similarly suspended ceilings may be provided wherein the plaster board is suspended from a framing structure to thereby reduce the degree of vibrational transmissioner of sound between the spaces separated by the plaster board.

Such additional steps in providing a further sound proofing can however be costly and it is advantageous if a single sheet of a building panel can be provided wherein significant or adequate sound absorption effects are provided by that panel alone. It will be appreciated that the provision of a rubber intermediary member adds steps to the installation procedure of lining a room of a building.

The sound transmission loss of wall-barriers is determined by physical factors such as mass and stiffness. In double layer assembly, as in gypsum wallboard on no non-continuous wood framing, the depth of air spaces, the presence of sound absorbing material and the degree of mechanical coupling between layers critically affect sound transmission losses and therefore the sound transmission class (STC).

Renewed interest in reducing noise in living chambers has motivated research in structural-acoustic analysis. Sound is generated by creating disturbance of the air, which sets up a series of pressure waves fluctuating above and below the air's normal atmospheric pressure. These pressure waves propagate in all directions from the source of the sound. There are many sources of sound in buildings: voices, human activities, external noises such as traffic, entertainment devices and machinery. They all generate small rapid variations in pressure about the static atmospheric pressure; these propagate through the air as sound waves. The nature of excitation may be unique to each chamber, the internal sound field in the enclosed area is significantly affected by: the acoustic modal characteristics of the special structured surface cavity created by the anhydrates (gelling

material), the dynamic behaviour of the surrounding structure, and by the nature of the coupling of these two dynamic systems. In addition, depending upon the relative value of the panel and gap resonant frequencies, sound transmitted to the receiving chamber may be amplified rather than reduced.

Two basic aspects govern the acoustical conditions in rooms: first the amount of background noise, and second the acoustical properties of the room itself, as determined by the geometrical arrangement and materials of the room. On the other hand, there are three steps to the acoustical design rooms: first selecting optimum criteria to be achieved dependent on the intended use, second designing to achieve these criteria, and third verification that the design goals are achieved in the finished building. It is common knowledge that for typical partitions, the transmission loss is much smaller for low frequency sounds than for high frequency sounds.

Accordingly it is an object of the present invention to provide a panel which overcomes the abovementioned disadvantages or which at least provides the public with a useful choice.

The concept of sound transmission of prismatic surface cavitated core of a wall barrier is of a significant importance in the research for more cost effective methods related to development of acoustic wallboards.

The sound transmission losses of a single or double layer walls are determined by the physical properties of the component materials and the method of assembly.

We believe that noise management of the whole system will dictate whether the subsystems will perform satisfactorily. Furthermore, it is estimated that the major failures can be avoided by proper design and suitably implemented wall barriers. The rate of noise failures can be reduced effectively if corrective measures are taken by the whole industry.

Accordingly the present invention consists in a panel comprising

a first layer of a gypsum material providing an exterior surface of the panel and provided on the other surface thereof a second layer of material

said second layer including a gypsum having a plurality of substantially homogenously provided cavities, said cavities having been provided by an anhydrate material which upon the release of water therefrom has shrunk leaving a said plurality of

cavities.

Preferably provided on the surface of said second layer away from said first layer there is provided a third layer which cover the other surface of said second layer.

Preferably said third layer is substantially similar to said second layer said third layer.

Preferably said third layer has a normal to the exterior surface thereof projecting in the opposite direction away from said panel to the normal of the exterior surface of said first layer.

Preferably at least one of said first and third layers is provided with a textured surface consisting of a plurality of upstands preferably provided as a pattern to the exterior surface of the at least first or third layer.

Preferably said upstands are prismatic in shape.

Preferably said first and third layer is substantially of gypsum.

Preferably said third and first layer includes EVA.

Preferably said first and third layer includes a fibreglass.

Preferably said cavities include a polyacrylate.

Preferably said cavities include potassium polyacylate.

In a further aspect the present invention consists in a method of providing a panel which comprises the steps of

a) providing a hydrated mixture of gypsum precursor and anhydrate provided homogenously there through to a layer preferably also of a hydrated gypsum but without said anhydrate,

b) allowing dehydration and hence a hardening of the materials to occur.

Preferably the method further includes the provision of a layer of materials to the exposed surface of the layer of hydrated gypsum and anhydrate.

Preferably said third layer is of a gypsum material.

Preferably said anhydrate is a polyacrylate.

Preferably said polyacrylate is potassium acrylate.

Preferably said third layer is applied in a dry powdered form to the upper surface of said second layer.

Preferably said third layer is applied when the second layer is still at least partially hydrated.

Preferably said third layer prior to it setting is screeded to provide the desired surface texture.

Preferably a fibrous material is laid into at least one of the layers.

Preferably said fibrous material is fibreglass.

Preferably said fibreglass is laid into al of the layers.

In a further aspect the present invention consists in a space laminated wall (not limited to its orientation to the horizontal) secured to a structural component(s) of a building said wall comprising

a first sheet and at least one other sheet

said first sheet mounted from said structural component

said second sheet mounted from said first sheet in a substantially parallel manner but separated therefrom to define a space there between by at least one kind of spacer.

Preferably said at least one other sheet is mounted outwardly away from said structural component with said first sheet.

Preferably said first sheet is of a kind as herein before described.

Preferably said at least one other sheet is a solid gypsum board.

Preferably said spacer is at least one of a foamed rubber material and adhesive.

Preferably said first sheet is affixed to the structural component via at least one rail.

Preferably said rail is nailed or screwed to a structural component such a stud and said first sheet is in turn screwed to said rail at appropriate intervals.

Preferably the surface of said first panel exposed in said space is of a non smooth surface.

Preferably said surface of said first panel exposed in said space is profiled.

Preferably said surface of said first panel exposed in said space is profile to define surface upstands preferably of a repeating pattern.

Preferably said wall is made up of a plurality of juxtaposed first and at least one other sheets in an edge to edge arrangement.

Preferably said spacer is a strip material and extends at least proximate to the perimeter of the wall defined by the juxtaposed sheets.

This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

Figure 1 is a sectional view through a preferred form of the panel of the present invention,

Figure 2 is a side view of a panel of the present invention,

Figure 3 is a sectional view through an installation which includes the panel of the present invention to define a sound absorbing wall structure,

Figure 4 illustrates a means of joining adjacent panels,

Figure 5 illustrates an arrangement for supporting a panel from a vertical or horizontal surface,

Figure 6 illustrates a method of fixing a series of panels to a wall structure wherein the assembly provides enhanced soundproofing,

Figure 7 illustrates an example of an assembly of a wall utilising the panel of the present invention in conjunction with additional panels and framing,

Figure 8 illustrates a prismatic surface texture provided on the panel of the present invention,

Figure 9 is a view of the core of the panel of the present invention,

Figure 10 is an illustration of the setup of the acoustic testing room, and

Figure 11 is a graph of results of the testing as hereinafter described.

The proposed panel provides a convenient way of absorbing noise transmission and is maintained within a standard thickness commonly used in building trades. The face gauge consists of a gypsum based material and provides a high density thin wall. While the body gauge consists of a gypsum material mixed with anhydrite gelling material. The gelling material is a product, which upon contact with water, results in rapid swelling as a

result of electrical forces pushing the inward structure of the particle away from the centre. When water is drawn away from the polymer the particle shrinks in volume. Fiber roving is provided to the body layers to strengthen their surface. Further additives, like EP hardener and anti-fungal agents are provided to the gypsum for purpose of hardening the surfaces. Post curing, cavities are formed within the body gauge. These cavities provide sound wave dissipation. Noise that flanks past the body gauge is in part reverberated back to the cavities from the backward high-density face. As a result of the core cavities within the body gauge, the entering sound waves are internally reflected and dissipated.

It is important to recognise that the overall function of a wall, in conjunction with floors, and roofs, is to provide a barrier between two environments, so that one environment can be adjusted and maintained within acceptable limits.

A wall is a selective separator between two spaces where between an actual or potential flow or energy is involved. The greater the difference between the two spaces the greater is the stress of duty imposed on the wall. Thus, the elements of the wall must be selected so that in the first instance they impart the necessary resistance to keep noise levels within acceptable limits. The way they are arranged, however, is also important. This will determine the variation in conditions throughout the wall. Interaction between various factors involved may produce conditions within the wall that require special attention.

The panel of the present invention provides a convenient way of absorbing some noise transmission through the panel while still allowing it to be maintained within a standard thickness wall panel which are commonly used in the building trade and in configuration preferably includes two layers of a gypsum based material. A first layer also herein referred to as the face gauge 1 consists of a gypsum based material and provides a substantially solid thin walled section to the panel of the present invention. The face gauge is that layer of the panel which provides its exposed surface 2 to be provided in a condition in use to be exposed into the room but which can later be subjected to further treatment such as priming and painting or for the application of a paper layer or similar cellulosic material.

The face gauge 1 is preferably of a high density material and hence in the method

of providing the panel, this face gauge is preferably in a form to provide a high density thin wall to the panel and may be for example be provided by a reasonably low water content wet mix of solidified gypsum pre-cursor. The face gauge 1 is provided in a mould or onto a mould in its wet form and is spread to a thickness of for example 2mm. Provided on top of the face gauge (i.e. against the surface of the face gauge away from the exposed surface 2 of the face gauge is a material which is herein defined as the body gauge 3. The body gauge consists of a gypsum material which has been mixed with a hydrated gelling material such as an anhydrate as potassium polyacrylate. An example of a potassium polyacrylate is that known by the trade mark TERAWET™ which is a crosslinked potassium polyacrylate/polyacrylamide copolymer which comes in the form of white granules and has a bulk density of 540± 40 grams per cubic meter. Its Ph value is somewhere between 6-6.8. Terawet™ is a product which upon contact with water results in rapid swelling as a result of electrical forces pushing the inward structure of the particle away from the centre. Small spaces are created inside the particle which attract water. When water is drawn away from the polymer the particle shrinks in volume. With the provision of hydrated potassium polyacrylate with the gypsum to define the body gauge, a substantially solid, in its wet form, layer of material is applied to the inwardly facing surface 10 of the face gauge 1. This body gauge may then be allowed to cure along with curing of the face gauge. However preferably a third layer, a backing gauge 4 is provided to the then upwardly facing surface of the body gauge 3. The backing gauge is preferably made of a substantially similar material to the face gauge 1. The body gauge may be provided in the form of 8.5mm layer intermediate of the vacuum gauge and face gauge. Further intermediate layers may be provided of a different kind however the most preferred form of the panel is as shown, in cross section in Figure 1.

Upon the curing of the gypsum material moisture is drawn out from the wet phase of the face, backing and body gauges. As the potassium polyacrylate also contains water, upon the curing of the panel, that water is removed from the potassium polyacrylate. The potassium polyacrylate becomes dehydrated and reduces in volume. As it reduces in volume, cavities are formed within the body gauge such cavities being substantially of a size of the wet or hydrated phase of the potassium polyacrylate.

After hydration, the swelled anhydrites at the core of the prismatic sheet shrinks to form small beads of approximately 1mm3 in volume. The result is aerated cavities 30-40 times larger than the bead. The dried anhydrites can re-swell to its original cavity mass when atmospheric moisture conditions are present. This phenomenon can occur repeatedly in a consistent manner without affecting the absorption properties.

On average, the interior of a dwelling in New Zealand produces approximately 7 liters of water a day. This is generally made of atmospheric moisture produced by plants, people, animals, cooking, showering, appliances, gas heaters, clothes dryers and others. External conditions add to that moisture level through open windows, doors, floors and structural cracks allowing water ingress.

During the day the temperature inside the dwelling increases and is contained by the insulation within the structure. The moisture from all of the contributors dwells with warm air and liquefies when it touches a cold surface. If this phenomenon is not vented properly, one can expect windows and wall areas to be saturated and the structural integrity could be compromised.

Most wall linings are made of a porous material; the saturation effect can easily soak into and through the lining material.

The anhydrites within the prismatic sheet will absorb and contain water ingress and release it when appropriate warm atmospheric conditions are present.

Releasing the captured water when conditions are controlled mechanically or at a natural atmospheric releasing point will minimise damage to the structure through wet/dry-rot, mould and mildew.

At the casting stage an anti-mould and fugal agent is added to the casting gauges to combat the problems associated with water ingress namely, product breakdown, rot, mildew and mould growth.

It is suggested that when the anhydrites are re-swelled, the transmission loss across the wallboard will reflect a gain because of the increased sound wave refractions occurring at these places.

The shrinking of the potassium polyacrylate therefore leaves cavities within the panel. The application of the backing gauge to form part of the panel of the present

invention, is achieved during the curing of the face and body gauge. As the curing of the face and body gauge takes place, moisture is floated to the surface of the body gauge. This moisture can be removed by the application of gypsum powder to the upper surface of the body gauge as the moisture is transferred therefrom. The application of gypsum powder to the upper surface of the body gauge provides the backing gauge to the panel of the present invention. In order to achieve a smooth surface to the backing gauge the powdered gypsum that is applied to the surface of the body gauge is smoothed by for example a screed. The thickness of the backing gauge can be built up appropriately to cover the upper surface of the body gauge and to thereby define a panel which is of a desired thickness. By way of example, the thickness of the panel may be provided to approximately 12.5mm.

Cavities in the body gauge, provide a disruption of reverberation of sound through the panel. The panel allows for mild reverberation of the face gauge allowing for a reasonably high percentage of noise to pass through to the body gauge. The reverberation of sound in the body gauge can be captured in the cavities in providing a dissipating effect of the noise. Noise that flanks past the body gauge is in part reverberated back to the cavities from the high density backing panel 4. As a result of the cavities within the body gauge of the panel of the present invention, sound that enters therein is internally reflected and eventually some if not most is absorbed.

To provide strength to the panel, fibre rovings may be provided throughout the panel or provided within at least one of the gauges and preferably within the body gauge 3.

The panel of the present invention with the inclusions of a dehydrated and hydrate will also provide some degree of humidity or moisture absorption.

Further additives may be provided to the gypsum material for the purposes of hardening and such materials may include EPA and indeed anti-mould or antifungal agents may be added particularly considering the possibility of moisture absorption being provided by the anhydrates. Table 1 shows one example of material detail. Table 2 shows an alternative.

The panel of the present invention may further be provided with a surface

modification to at least one of the outwardly facing surfaces of the face gauge or backing gauge 1,4. Such a surface modification is by way of a pattern of upstands provide and a disruption to the otherwise flat exterior surface of the panel.

With the provision of surface modifications to at least one and alternatively to both of the outwardly facing surfaces of the panel of the present invention, further sound absorption may be catered for. Surface upstands which may be provided as a pattern to the surface of the panel can provide further sound deflection and with reference to Figure 3, wherein the panel is provided within a sound absorbing structure, the surface modifications 12 may be provided exposed into a cavity which is defined between the panel and an other like or other type of panel 13. The panel 13 may be a standard plaster board sheet which is provided in association to the panel of the present invention and wherein the surface modifications 12 are provided within the cavities provided between two panels 14, 13. The surface modifications will provide a disruption to the sound waves endeavouring to travel into the panel 14 from any sound transmitted from the inwardly facing surface of the panel 13. To prevent direct vibrational transmissions between the two panels a spacer 15 of a low hardness material such as a foamed rubber which is provided to create a space lamination.

may be provided at appropriate locations between the panels 13 and 14. This spacer will reduce the incidence of material vibrational transmission of sound.

The panel 14 is preferably mounted to a frame work structure 16 of a building such as timber framing by way of mounts 17. Such mounts may be rails of an extruded or roll formed kind to which the panel structure of the panels 13, 14 are mounted. Rubber grommets 21 or strip material may be further provided intermediate of the structure 16 and the mounts 17 and/or between the mounts 17 and the panel 14. With reference to Figure 5, there is shown a detailed view of the arrangement wherein the panel is provided to a timber framing as for example shown in Figure 16.

A putty like material may be provided to overlay the positions where the fastening means 22 may be provided to secure the panel 14 to the rails 17. The application of such a putty 23 provides a sound seal to the migration of sound via the fastening means 22 to or from the other side of the panel 14 to which it is provided.

With reference to Figure 6, a wall utilising the panel construction of the present invention may be provided wherein a plurality of panels are provided adjacent to each other. Such a plurality of panels 20 are preferably engaged to adjacent like panels as for example shown in Figure 4. A sound sealing material 25 may be provided intermediate of the panels to thereby reduce transmission of vibration between adjacent panels.

The spacer seal 15 may extend around or approximate to the formed perimeter of the plurality of panels and intermediate of the spacer there may be provided a sound absorbing putty 26. Such a sound absorbing putting for similar material may also be provided external of the seal 15.

The exterior panel 13 may preferably be adhered to the panel 14 by adhesive regions 27. The adhesive is that which holds the facing panel 13 to the inner panel 14.

Another mode of fixing is shown in Figure 7. The first sheet is fastened to the framing using 32mm screws about 300mm ctrs to all intermediate studs & noggings and around the perimeter.

Sound seal is placed to the inside of the high-density foam seal around the perimeter.

The 13mm noiseline sheet is secured by means of glue daubs about 300mm ctrs to the body of the sheet in line with the intermediate studs and secured around the perimeter about 300mm ctrs with 51mm screws.)

When lightweight construction and high STC values are desired, the proposed wall barrier can be used. Important factors, in addition to masses of the component layers, are the depth of air space, the use of sound absorbing materials within the air space and the rigidity of the mechanical coupling between the layers. The used assembly has no rigid mechanical connection between the surfaces. The air trapped between the layers acts as a spring and the mass-air-mass resonance, occurs at a frequency:

$$fmam = 1897 \sqrt{m1 + m2} / \sqrt{D\, m1\, m2}$$

where, m1, m2 are the surface masses of the layers, kg/m2 and D is the distance between the layers, mm. The larger the air space or the heavier the materials, the lower the

frequency at which resonance occurs. Adding sound absorbing material reduces the negative effects of this resonance. The mechanical connection between the layers of the wallboard is reduced by the use of separate rows of wood studs to support the wallboards independently of each other.

TABLE 1

Type	Gauge	Weight Per Thickness	Thickness
Swelled anhydrates	Body	1.42 kg/m^2	8.5mm
Hardened (EPA)	(i) Face (ii) Backing (iii) Body	19mlt/m^2 76 mtl/m^2	2mm 8.5mm
Fiber-glass strands	Body gauge surface	220 gms/m^2	8.5mm

In designing the wallboard several factors were taken into account. These include the right weight for swelled anhydrites (gelling material added to the body gauge), the right amount of a typical hardener (EP hardener) which is added to both the face and body gauges, the fiber-glass strands, and a prism shaped surface layer. Table 2 gives weight values of components for the improved mix at a mass quantity gauge ratio of 100 : 60.

TABLE 2

Type	Gauge	Weight
Swelled anhydrites	Body	1.54 kg/m^2
Hardener (EPH)	(i) Face (ii) Body	61.7 mlt/m^2 185.2 mlt/m^2
Fiber-glass strands	(i)Face layer (ii)Body layer	24 gms/m^2 208 gms/m^2

EXPERIMENTAL RESULTS

In this work the sound transmission characteristics of a prismatic surface (Figure 8) cavitated core (Figure 9) of a wall barrier is investigated on classical lines.

The proposed panel provides a convenient way of absorbing noise transmission and is maintained within a standard thickness commonly used in building trade. By enlarging

the surface cavities and further hardening the panel structure layers increased the transmission loss.

The investigation suggest for a best panel structural texture the following features are to be included:

1) A low-density prism for the surface panel texture,

2) A consistent distribution of prism over the whole surface,

3) Consistent depths caused by these prisms,

4) Hardening of both the face and body gauges,

5) Even distribution of correct amount of swelled anhydrates at body gauge, and

6) Using a suitable double non-continuous frame setting, separated with minimum suitable space to avoid resonance.

Tests were conducted at the University of Auckland Acoustic labs. The wallboards were fully cured without surface damages. Test results indicate that the new panel has an STC of 63 Db. This value is higher than those reached with locally and internationally (Canada and USA) produced acoustic panels of similar configuration.

The results also showed a significant improvement to the lower ranges of frequency (between 50 – 160 Hz). Wave resonance was found to have a negative effect on the middle ranges shown on the transmission loss diagram (between 200 – 630 Hz). This effect can be avoided by increasing the air space between the non-continuous wooden frames. Tests were conducted to find the optimum airspace between frames to suppress resonance. Flammability index of the examined wallboard material was also determined using standard tests.

The cavitated surface panel consists of two faceplates of the same material and thickness, with a constrained viscoelestic damping junctions in between, set on non-continuous wooden frame using absorbing material placed between the two boards.

It is shown by analysis that the core shear parameter has a significant effect on the noise transmission characteristics of the proposed panel, which has better sound transmission characteristics than a homogenous panel, for two reasons: first, the coincidence frequencies are shifted to higher frequency ranges, and second, the coincidence transmission loss is considerably increased due to the presence of the cavities

on the layer surface.

Tests were conducted on the new panel at the University of Auckland Acoustic Laboratories. Sound transmission loss is measured by testing in two separate rooms highly reverberant not in solid contact with either of them. A loud speaker and amplifier are used to generate random sound in one of the rooms and sound energy passes through the partition into the second receiving room (Figure 10):

The level in the receiving room is partly determined by the area of the partition and the total absorption of the receiving room. The larger the sound transmission class (STC) value, the better the partition (less sound energy passes through it).

The reverberation time in the echoic chambers was optimised. The reverberation time is directly related to the room volume and inversely related to total absorption in the room. The reverberation time is calculated using Sabine reverberation time equation:

$$RT = 0.161\ V/(\alpha\ S + 4\ m\ V)$$

where:

V is the room volume in cubic meters,

α is the mean absorption coefficient,

S is the total surface area of the room, in square meters,

m is the energy attenuation constant per meter due to air absorption.

Figure 11 shows the test results of the improved wallboard panel. The results indicate an STC for the panel of 63 dB. This value is higher than the commercial wallboard of similar configuration by 9 Db (STC of commercial wallboards is 54 dB). The value reached is also higher than commercially applied wallboards of similar configuration in both Canada and USA, were they stand at 58 Db.

An important improvement is achieved on the low frequency range (between 50 – 160 Hz). On curve of Figure 11, the variation of the transmission loss is shown with frequency:

- For low values of frequency (between 50 – 160 Hz) the transmission loss curve follow the mass law. It shows significant improvement.
- At mid-ranged frequencies (between 200 – 630 Hz) a deviation from the mass law

takes place. This is attributed to the fact that at this range the wave resonance acts to increase the frequency values. The larger the air space between the double layers or the heavier the materials, the lower the frequency at which resonance occurs.

– For higher frequency ranges, the transmission loss curve follows the mass law again. The curve shows that the TL is significantly higher at intermediate frequency range (1000 – 2000 Hz). This is mainly due to the fact that the coincidence frequencies are much higher than for the larger values of frequency. A sharp drop in LT is noticed between (2000 - 2500 Hz) to then increase rapidly with increase in frequency (2500 – 4000 Hz).

To maximize the improvement due to airspace, frames should be designed so that the mass-air-mass resonance is at the lowest frequency as possible. Many common frame designs do not meet this criterion. The air trapped in the space between the layers acts as a spring transferring vibration energy from one frame to the other.

DATED THIS 6th DAY OF May 2003

AJ PARK

PER NKMcE

AGENTS FOR THE APPLICANT

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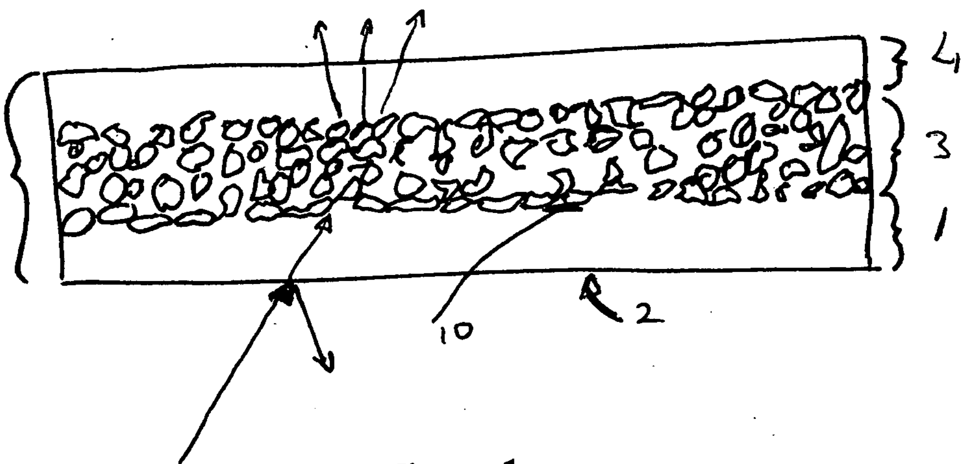


Figure 1

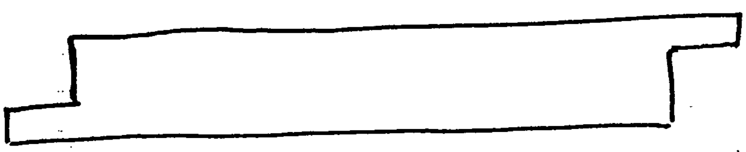


Figure 2

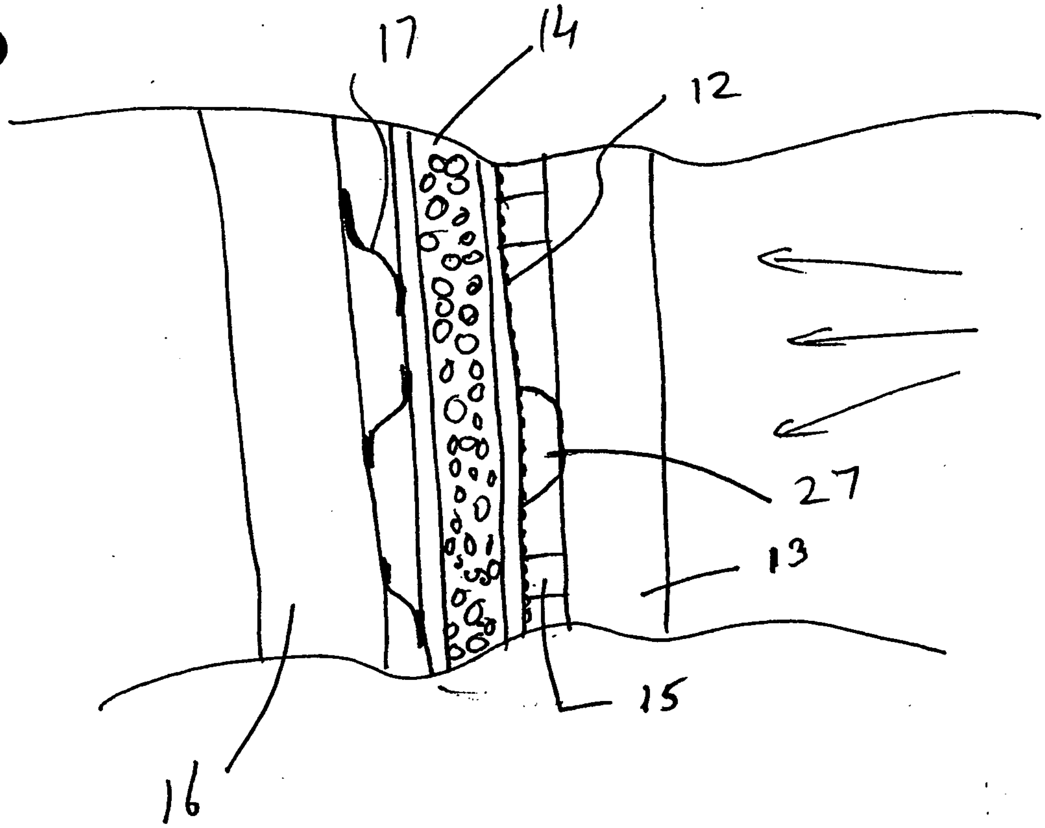


Figure 3

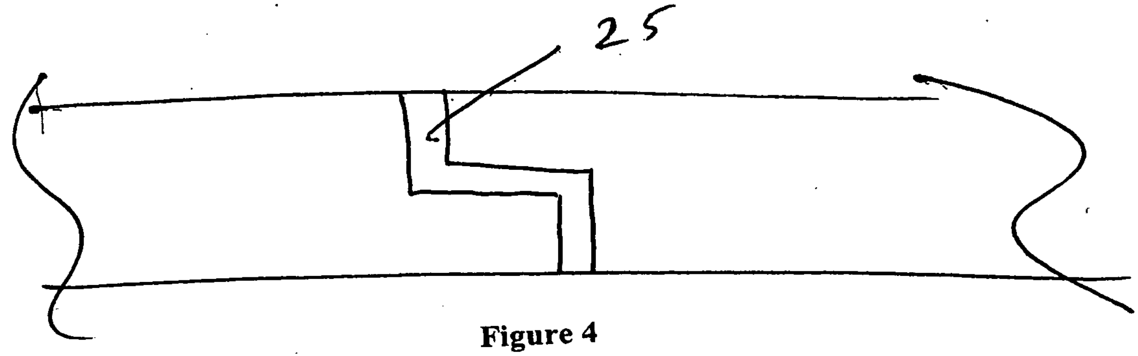


Figure 4

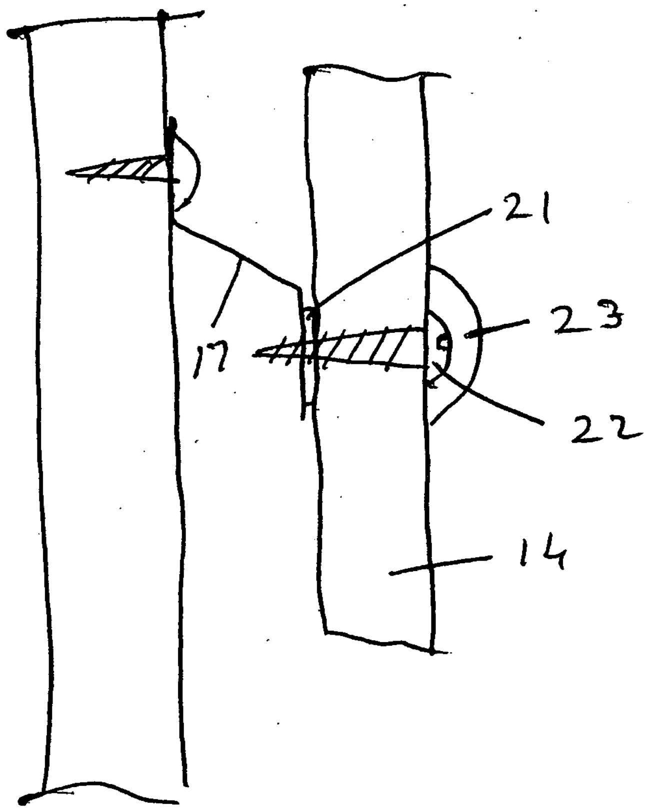


Figure 5

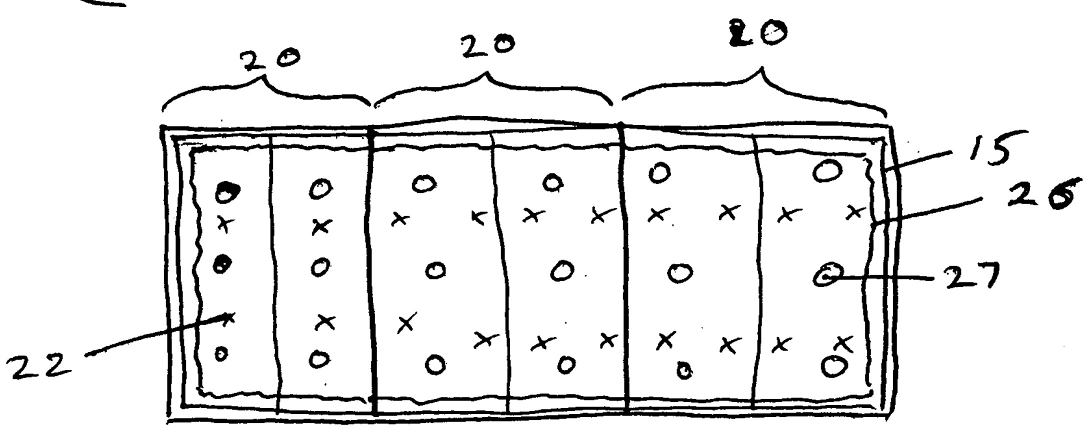


Figure 6

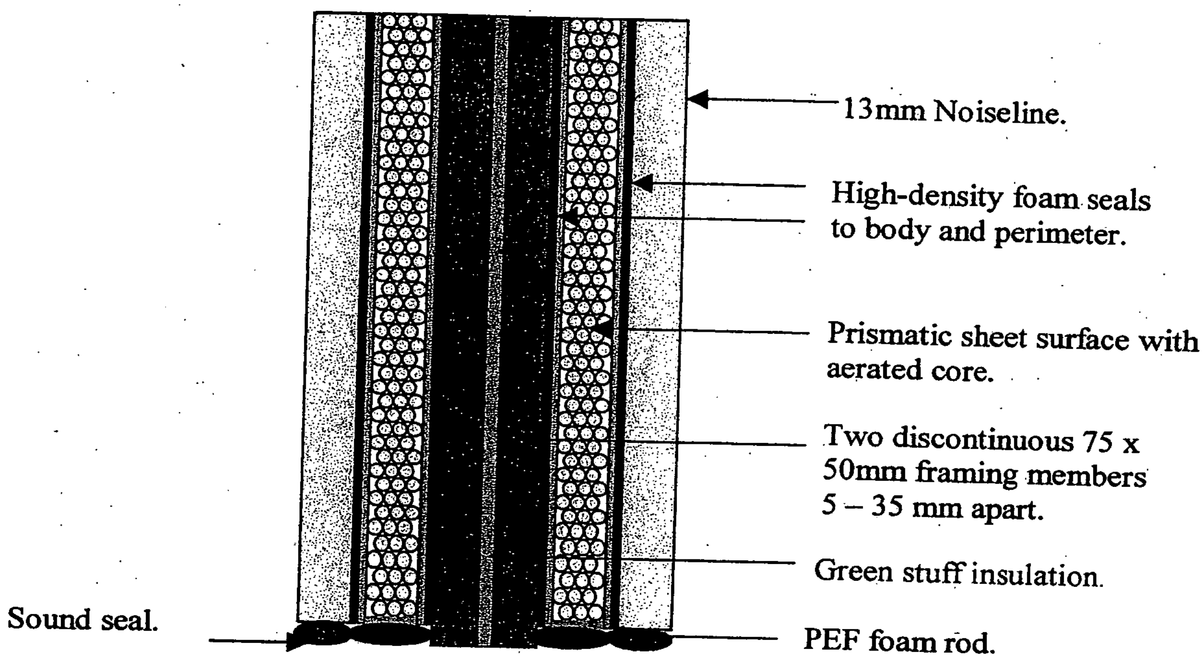


Fig 7

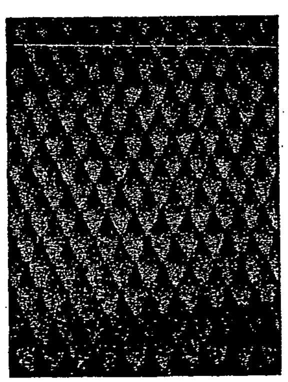
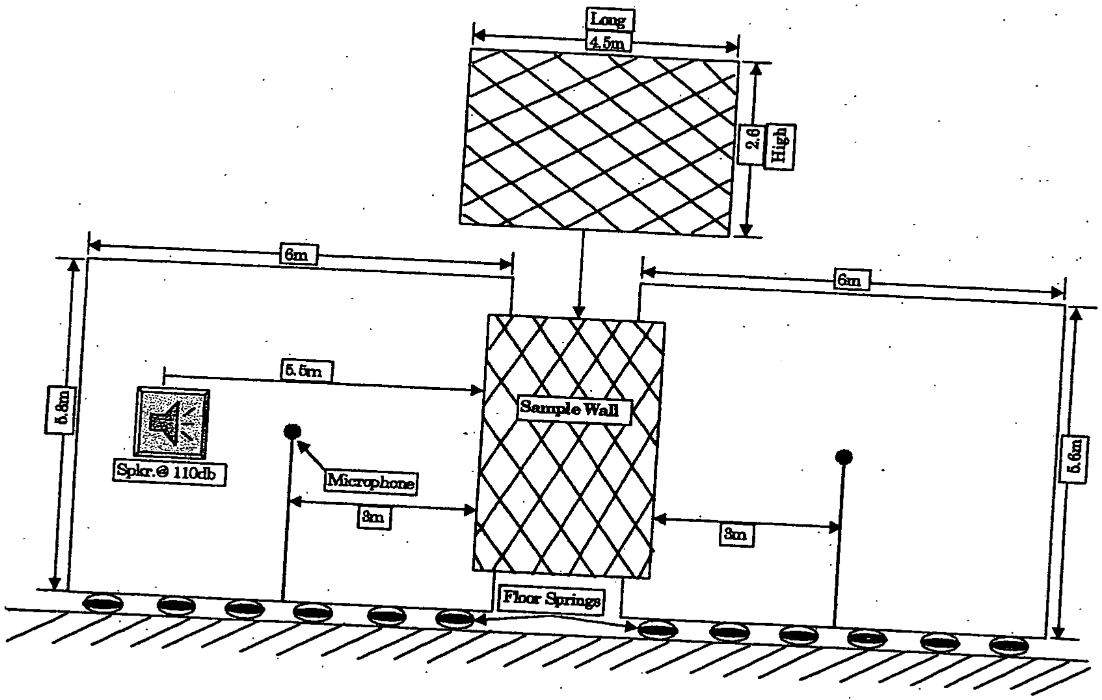


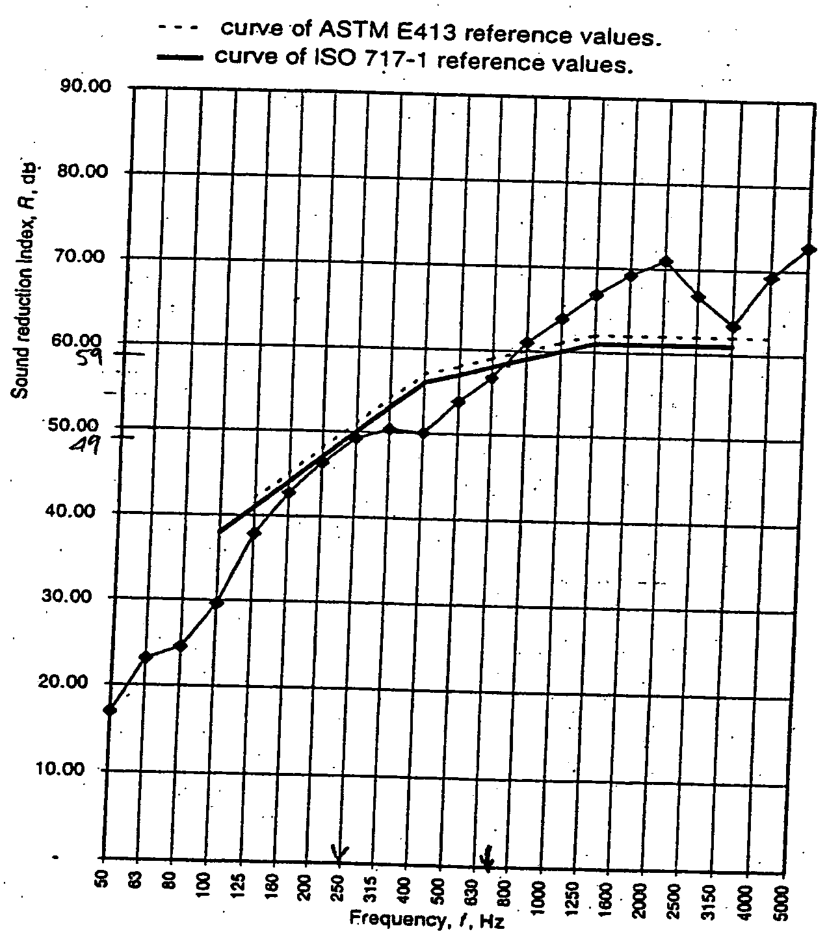
Fig 8

Fig 9



Long
4.5m
2.6
High
6m
6m
5.8m
5.6m
5.5m
Sample Wall
Spkr.@ 110db
Microphone
3m
3m
Floor Springs

Fig 10



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1250
1600
2000
2500
3150
4000
5000
Frequency, f, Hz

Fig 11